EXHIBIT 4

Modification of Laying Hen Cages to Improve Behavior

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ABSTRACT Although they have many disadvantages for welfare, including for behavior, laying hen cages also have advantages. For example, aggression and cannibalism (or the need for beak trimming to prevent these) are usually less than in other systems, benefiting both the birds and the producer. There have been three approaches to reducing other behavioral problems. First, the design of conventional cages has been improved, which has had favorable effects on some aspects of behavior, such as feeding. Second, cages for larger groups of birds have been tested; for example, the getaway cage has increased behavioral freedom but has also increased problems such as aggression and cannibalism. Third, novel cages have been designed for conventional group sizes. Many of the behavioral problems—for producers, birds, or both—occurring in conventional cages can be reduced or prevented by increasing cage area (including width) and height and by providing a nest box, dust bath, and perch. Some of these modifications could be implemented at negligible cost to the producer. Others will be commercially viable if premium prices are available for eggs or if legislation on housing of laying hens changes.

(*Key words*: behavior, layer, modified cages, welfare)

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INTRODUCTION

It is widely acknowledged that there are major welfare problems for laying hens in conventional cages (Nicol, 1987; Appleby, 1991; Baxter, 1994). These problems led the UK's Farm Animal Welfare Council (FAWC), for example, to conclude that "We do not approve of the cage systems in their present commercial form on welfare grounds" (FAWC, 1986), and cages are now banned in Switzerland. One of the most important areas of criticism is the effects of cages on behavior. Thus, the first four disadvantages of cages listed by FAWC concerned behavior, namely: there are no nesting facilities; wing flapping is prevented and other exercise is limited; no dust bathing is permitted; birds cannot escape other birds. However, cages also have welfare advantages over alternative husbandry systems, including behavioral ones. These advantages are largely associated with the fact that birds are kept in small groups and under hygienic conditions (Appleby and Hughes, 1991; Sherwin, 1994). Cages also have economic advantages, and poultry systems have to be economically viable if producers are to stay in business. For these reasons, there have been several projects aimed at modifying cages to reduce their disadvantages while retaining their advantages (Appleby, 1993; Alvey and Tucker, 1994; Nicol and Sherwin, 1994; Rauch, 1994). This paper reviews the extent to which behavioral problems—for producers, birds, or both—occurring in conventional cages or in alternative systems can be reduced or prevented in modified cage designs.

ADVANTAGES OF CAGES FOR BEHAVIOR

Cages already give significant advantages to the producer in controlling behavior: this was one of the major reasons for adoption of cages. For example, cages avoid the important problem found in all other systems of some hens laying on the floor rather than in nest boxes. They also largely prevent the problem of egg eating because eggs roll away rather than remaining accessible to the birds.

Furthermore, cages reduce or prevent a number of behavioral problems that are important for both welfare and production, thereby giving advantages to both the producer and the birds. Aggression is less frequent in cages than in any other system except the perchery

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Abbreviation Key: FAWC = Farm Animal Welfare Council.

(McLean *et al*., 1986) and cannibalism, although variable and affected by many factors, tends to be less common in cages than in noncage systems. Beak trimming, which reduces both these problems but is itself subject to criticism on welfare grounds (Hughes and Gentle, 1995), is therefore usual in the latter systems. Its use for caged birds is questionable and probably less common. The low frequency of aggression and cannibalism in cages is probably related to the small group size (Appleby *et al*., 1992), a feature that can be retained in modified cages.

The restricted environment of cages, despite its disadvantages, results in avoidance of two other problems. First, use of nest boxes is sometimes associated with development of extreme gregariousness, with consequent breakage of eggs and even the suffocation of birds, and this behavior cannot happen in cages. Second, birds in systems such as aviaries and percheries are liable to break bones during the laying year by colliding with parts of the structure while jumping or flying. Birds from these systems therefore have more old breaks at end of lay than caged birds even if they are less liable to new breakages (Gregory and Wilkins, 1989; Gregory *et al*., 1990).

It has already been mentioned that one additional advantage of cages is hygiene. Preventing birds from mixing with many other individuals and from coming into contact with feces reduces the incidence of disease, which again benefits both welfare and production.

REDUCING PROBLEMS OF CAGES

It remains true, however, that there are many problems for hens' behavior in cages. Furthermore, prevention of some problems causes others: for example, those associated with restricted environment. There have been three approaches to reducing such problems. First, the design of conventional cages has been improved; second, designs have been developed to house larger groups of birds; third, novel cages have been designed for conventional group sizes. These approaches will be considered in turn.

Improvements in design of laying cages in recent years have led to welfare benefits such as reduced incidence of trapping and injury of hens (Tauson, 1988). Some of these improvements also affect behavior, if in a minor way. Thus, simplified cage fronts with horizontal bars encourage the tendency of birds to feed at the same time (Sherwin, 1992), allow easier movement along the feed trough and reduce feather wear during feeding (Elson, 1988). However, these changes clearly do not address most of the problems of cages.

The modified cage that has received most attention has been the get-away cage (Elson, 1981; Wegner, 1981). This cage incorporates perches and nest boxes and allows a greater freedom of movement vertically as well as horizontally for groups of up to about 60 birds. Early versions of this cage type had a flat floor and littered nests, but floor laying and dust-bathing in nests were problems, and sloping floors and rollaway nests (without litter, allowing eggs to roll away) have supervened (Wegner, 1990). Unfortunately, the increase in group size compared to conventional cages has meant that aggression, feather pecking, and cannibalism have sometimes been severe. In addition, there are hygiene problems because birds sometimes defecate on each other. In all these large cages, inspection and catching of birds are also more difficult than in conventional cages.

The simplest modification to the conventional cage design is the shallow or reverse cage, in which the usual narrow / deep dimensions of cages are reversed. This allows all birds to feed simultaneously (Hughes, 1983). Another simple change is addition of a perch, which has actually been put into practice on one commercial unit (Rockcliffe, 1991). In shallow cages, it is possible to fit a perch across the width of the cage long enough for all birds to perch at the same time. Perches encourage normal roosting behavior (Tauson, 1984) and, depending on design, may also reduce foot problems and bone weakness (Hughes and Appleby, 1989; Duncan *et al*., 1992). However, there is some indication that perches may cause deformation of the sternum, perhaps from pressure on the sternum during roosting combined with osteoporosis (Appleby *et al*., 1993), although implications of this for welfare are not known. Perches in cages also cause a production problem: they tend to increase the number of eggs that are cracked or dirty (Tauson, 1984). The perches have to be high enough for eggs to roll underneath, and hens lay from them, perhaps because they prefer a level perch to the sloping floor as a nest site (Duncan *et al*., 1992). One solution proposed was to have cages with moveable perches, which were raised above floor level at night but flush with the floor in the day (Luescher *et al*., 1982). An alternative that also allows more normal nesting behavior is to provide nest boxes in the cages (Appleby, 1990; Appleby and Smith, 1991; Sherwin, 1992). This alternative is consistent with the idea of an integrated approach to modifying cages so as to ameliorate most or all of their problems, as discussed in the next section.

BEHAVIORAL PRIORITIES IN CAGES

The main improvements for behavior needed for hens in cages are listed in Table 1. The experimental programs already mentioned suggest that these can all be achieved by modification of cages, at least to some extent. The benefits to producers considered in Table 1 relate only to the production process. In addition, in some circumstances, premiums are available for the sale of eggs from systems with improved welfare.

For the producer, improvements in production can be achieved by reducing overeating and the number of downgraded eggs. Overeating may be reduced by provision of a perch (Braastad, 1990), which has negligible cost (Elson, 1985). Downgraded eggs may be reduced by addition of a nest box to the cage (Appleby and Hughes, 1995), although this is more expensive.

TABLE 1. The main improvements in behavior needed for hens in cages

For producer	For producer and birds	For birds
Reducing overeating	Increasing movement	Allowing or increasing:
Reducing downgraded eggs	Allowing escape	Nesting
	Reducing fearfulness	Perching
	Allowing or increasing:	Stretching
	Pecking	Local movement
	Scratching	Synchrony
	Dust bathing	

There are a number of ways in which modification of cages can improve the behavior of birds and also benefit the producer, although as with nest boxes these will have costs. Such improvements include increasing movement (which increases muscle and bone strength), allowing escape (which reduces bullying and the tendency of low-ranking birds to go out of lay), and reducing fearfulness (which can cause injury, both during lay and at depopulation). These improvements can be achieved by increasing cage area, providing some divisions within the cage, and including a perch (the effects of which were discussed above). Hansen (1976) has discussed the effects of cage enrichment on fearfulness. In addition, allowing birds to use loose material, for example sand in a dust bath, has both behavioral and physical effects: pecking, scratching, and dust bathing behavior result in improved foot, claw, and beak condition (Fickenwirth *et al*., 1985) and feather condition. The latter, in turn, improves heat retention and feed conversion.

The last category of behavioral improvements are those beneficial to the birds but not necessarily to the producer. There is evidence that prevention of the following causes frustration or other problems for welfare: nesting, perching, stretching, and local movement (reviewed by Appleby *et al*., 1992). Nesting can be provided for by attaching a nest box to the cage as discussed in the next section. The other behaviors can be increased by providing a perch and increasing the cage area and height. In addition, hens attempt to perform a number of behavior patterns in synchrony. An increase in cage width allows hens to feed synchronously and a relatively slight increase in cage area also increases synchrony in other behaviors (Jenner and Appleby, 1991).

Some other behavior patterns are often mentioned that are not possible, or hardly possible, in cages, such as wing-flapping, jumping, running, and flying. These behaviors remain extremely limited in modified cages. Lack of these movements contributes to bone weakness (Knowles and Broom, 1990), and, therefore, to bone breakage at the end of the laying period during removal and transport for slaughter. However, other effects on welfare of the occurrence or prevention of these behavior patterns are unknown.

To summarize, most behavioral problems—for producers, birds, or both—occurring in conventional cages can be reduced or prevented by increasing cage area (including width) and height and providing a nest box, dust bath, and perch.

PRELAYING BEHAVIOR IN CAGES

As one example of the research necessary to design an environment that allows behavioral expression, the Edinburgh project on modified cages has involved a succession of trials of nest sites in cages. The first investigation was to determine whether part of the existing cage area could be modified to form an acceptable nest site, but it was found that for nesting behavior to be normal and relatively undisturbed by other birds, a nest site outside the main cage area was

TABLE 2. Recommendations from the Edinburgh project on modified cages

Feature	Requirements	Possible specifications
Perch	Space for all birds	140 mm/bird (medium hybrids)
	Good grip for feet	Softwood, rectangular cross section
	Space behind and in front	Across middle of cage
Nest site	Enclosed, protected	Nest box
	Limited competition	Space for 2 birds in group of 4 to 5 (250 × 480 mm)
	Suitable substrate	Litter or artificial turf
Dust bath	Suitable material	Sand
	Availability	Space for 2 (250 × 480 mm)
	Pecking possible	Door allowing pecking
Area	Local freedom of movement	675 cm^2 per bird (plus nest box, etc.)
	Perching and feeding side by side	140 mm wide per bird (medium hybrids) × 480 mm
Height	Clearance above perch	450 mm at back

necessary (Appleby, 1990). Best results were achieved with a single nest box large enough for at least two birds to nest simultaneously (Appleby and Smith, 1991), because when two nest boxes were provided, prelaying behavior was disturbed by birds moving between them, although this was not found to be a problem in another project (Sherwin, 1993) that fitted two nest boxes to cages. It may be possible to provide littered nest boxes with automatic egg collection, but it is probably a simpler solution to have rollaway nests lined with artificial turf. Consistent use and normal nesting behavior have been recorded with such nest boxes (Appleby *et al*., 1993). For practicality of egg collection, nest boxes can be fitted next to the cage; eggs then roll away on to the same cradle as any laid on the cage floor (Appleby and Hughes, 1995). Cages with attached nest boxes have been found to result in egg production rates comparable to or higher than those of conventional cages, with a comparable or lower incidence of cracked and dirty eggs (Appleby and Hughes, 1995).

IMPLEMENTATION OF IMPROVEMENTS

One formulation of the improvements and modifications discussed here is given in Table 2. However, this is not definitive and is likely to change in light of other projects and larger scale trials. Some of these modifications could be implemented at negligible cost to the producer. Others will probably only be commercially viable if premium prices are available for eggs or if legislation on housing of laying hens changes. It is to be hoped that producers and commercial companies will participate in discussions of possible modifications so that the industry can contribute to decisions about future developments.

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